



Health Hazards and Safety of Use of Hydrofluoric Acid for Ceramic Restorations

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Introduction

Hydrofluoric acid (HF) is a highly corrosive inorganic acid that is often used in dental practices to etch silica-based ceramic restorations. Silica-based ceramic restorations include, but are not limited to, feldspathic porcelains, leucite reinforced ceramics, fluoroapatite ceramics, and lithium disilicates. Hydrofluoric acid's function is to roughen and alter the surface of the ceramic, changing its surface free energy and increasing total surface area. As a result, bond potential to ceramic restorations is greatly increased when followed by bonding protocols with the appropriate coupling agent and resin substrate. Following HF acid application, the ceramic with the HF acid should be copiously rinsed for 60 seconds and placed in a neutralizing solution for at least 5 minutes. Even with its great restorative benefits however, the disadvantage to hydrofluoric acid is its potential harm to the clinician or lab technician, and if not appropriately cleaned before use, to the patient.

Health Hazards with Hydrofluoric Acid

Typically, dental HF acid solutions are within the range of 5-10% concentration. Solutions containing a concentration of 15% or greater tend to show effects immediately, while less concentrated solutions will have a delayed response. When HF contacts the skin or mucus membranes, it can cause local injury as well as potentially fatal systemic effects.^{1,2} Severe exposures will result in inflammation and/or ulceration of the tissue, but smaller exposures may have acute or chronic subclinical effects.

When contacting the skin, HF penetrates through the epidermal layer and into the dermis and potentially deeper. If spilled and/or inhaled, HF can also have pulmonary effects. If reaching bone or the blood stream, the fluoride ions combine with calcium and magnesium, which can lead to hypocalcemia and hypomagnesemia. The hypocalcemia may stimulate an efflux of potassium ions into the bloodstream, resulting in hyperkalemia.^{3,4} The primary cause of death with HF burns is from cardiac arrhythmias, which results

from the electrolyte abnormalities and direct cardiotoxic effects of highly concentrated fluoride.^{5,6,7,8}

Protective Measures to Prevent Exposure

The following measures should be taken in order to reduce the risk of HF exposure.

- 1) HF should NOT be used around the patient.
- 2) Annual training and awareness of HF's hazard potential; this training should be provided for anyone who has access to the room that contains HF acid.
- 3) All containers of HF should be clearly labeled.
- 4) HF acid should be stored in the corrosives locker.
- 5) When handling HF acid, appropriate Personal Protective Equipment (PPE) should be used in order to reduce the risk of skin exposure:
 - a. Goggles and face shield
 - b. Long sleeved shirt and closed-toe shoes
 - c. Butyl rubber or viton/butyl gloves for best protection. *Do NOT use latex gloves for they do not provide an effective HF barrier*
- 6) HF should only be used when appropriate treatment protocol can be immediately implemented post HF spill or exposure.

Recommendation of Action if Exposure has Occurred

If a HF acid exposure to the skin, eyes, or mucus membrane has occurred, the following action is recommended:

1. Wash exposure with copious amounts of water for 10 minutes.^{9,10}
2. Report to the Emergency Room for medical treatment.
3. Make triage staff clearly aware of potentially serious complications if treatment is delayed.

Treating clinicians may prescribe calcium gluconate gel (2.5%) to the exposed/burned areas.¹¹ The gel is massaged into the skin for 30-60 minutes with the massaging hand wearing surgical gloves.^{12,13} If pain persists, a 5% intradermal injection may be used near the site of exposure/burn. If the local pain has not subsided and/or systemic effects are a serious concern, calcium gluconate may be given intravascularly. Intravascular injections of calcium gluconate are best done in consultation with a medical toxicologist or a comparable expert.¹⁴

Note – The author is unaware of any notable distinction made between HF acid concentration and treatment for exposure. In other words, no distinction was found on whether lower concentrations of HF acid may not require emergency medical treatment. As a result, to the author's knowledge this recommendation of action is for all HF concentrations.

Conclusion

HF acid is an excellent adjunct to dental treatment that should have appropriate protective measures in place. In order to maximize safety, everyone in contact with the HF acid should be trained and made aware of preventive, as well as responsive, actions to take.

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